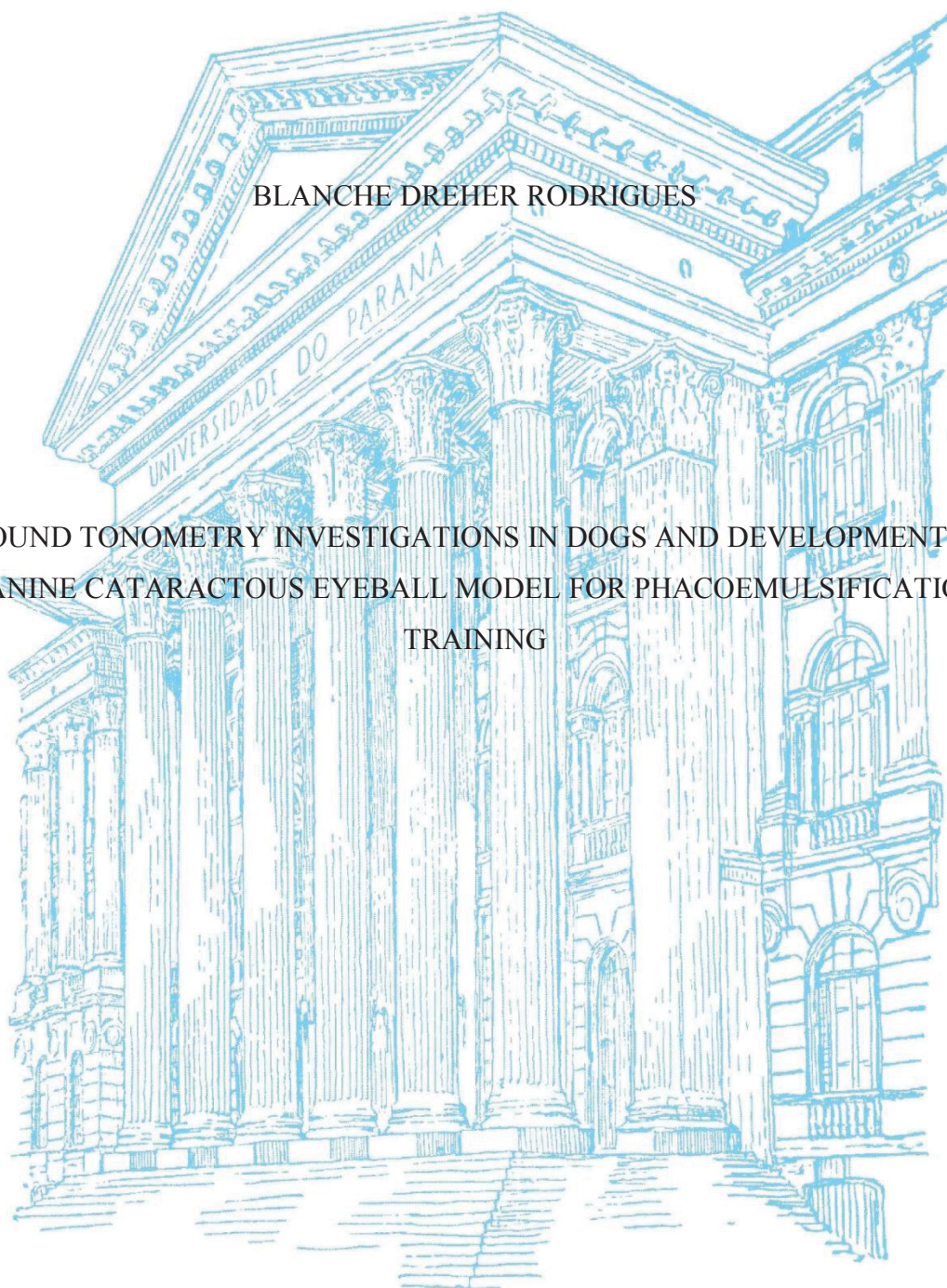


UNIVERSIDADE FEDERAL DO PARANÁ

BLANCHE DREHER RODRIGUES

REBOUND TONOMETRY INVESTIGATIONS IN DOGS AND DEVELOPMENT OF A  
CANINE CATARACTOUS EYEBALL MODEL FOR PHACOEMULSIFICATION  
TRAINING



CURITIBA

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TRAINING

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Orientador: Professor Ph.D. Fabiano Montiani-  
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## TERMO DE APROVAÇÃO

Os membros da Banca Examinadora designada pelo Colegiado do Programa de Pós-Graduação em CIÊNCIAS VETERINÁRIAS da Universidade Federal do Paraná foram convocados para realizar a arguição da dissertação de Mestrado de **BLANCHE DREHER RODRIGUES** intitulada: **REBOUND TONOMETRY INVESTIGATIONS IN DOGS AND DEVELOPMENT OF A CANINE CATARACTOUS EYEBALL MODEL FOR PHACOEMLUSIFICATION TRAINING**, sob orientação do Prof. Dr. **FABIANO MONTIANI FERREIRA**, que após terem inquirido a aluna e realizada a avaliação do trabalho, são de parecer pela sua aprovação no rito de defesa.

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“ E se o mundo não corresponde em todos os aspectos a nossos desejos, é culpa da ciência ou dos que querem impor seus desejos ao mundo? ”

“And if the world does not in all respects correspond to our wishes, is this the fault of science, or of those who would impose their wishes on the world? “

— Carl Sagan, *The Demon-Haunted World: Science as a Candle in the Dark*

## RESUMO

A presente dissertação é composta por dois capítulos, sendo eles artigos científicos na área da oftalmologia veterinária. Ambos os estudos foram conduzidos pelo autor. Todos os estudos foram conduzidos por membros do Laboratório de Oftalmologia Comparada (LABOCO) da Universidade Federal do Paraná. O primeiro capítulo compreende uma investigação sobre a influência da distância entre a ponteira do tonômetro TonoVet® e a superfície da córnea, nas medições de pressão intraocular em ratos e cães, abordando a importância de procedimentos padronizados, considerando as distâncias usadas entre o dispositivo e o paciente durante as medições da pressão intraocular, tanto na prática clínica quanto nas áreas de pesquisa. As medidas da PIO seguindo métodos de padronização de distâncias podem fornecer resultados mais precisos e melhor reprodutibilidade e repetitividade. O segundo capítulo desta tese teve participação de membros do Laboratório de Estudos em Modelagem e Monitoramento Ambiental (LEMMA), e se trata de um estudo que propõe um novo modelo de treinamento para cirurgia de catarata, através da facoemulsificação. Aspectos dos materiais utilizados e procedimentos sequenciais de sua construção foram relatados. Como o modelo de treinamento ainda está em fase de validação, onde cirurgiões veterinários, especializados em oftalmologia veterinária, testarão o modelo e responderão aos questionários da Likert para sua avaliação, os resultados serão relatados em etapas seguintes.

Palavras-chave: Oftalmologia veterinária. Tonometria. Modelo cirúrgico. Técnicas alternativas de ensino. Cães. Facoemulsificação.



## **ABSTRACT**

This dissertation comprises two chapters, which are scientific articles in the context of veterinary ophthalmology. The author conducted both studies. Members of the Comparative Ophthalmology Laboratory (LABOCO) of the Federal University of Paraná participated in all studies. The first chapter comprises an investigation about the influence of the distance between the TonoVet<sup>®</sup> tonometer probe and the corneal surface, on intraocular pressure measurements in rats and dogs, addressing the importance of standardized procedures considering the distances used between the device and the patient, during intraocular pressure measurements, in both, clinical practice and research areas. IOP measurements following distances standardization methods can provide more accurate results, and better reproducibility and repeatability. The second chapter of this thesis had participation of members of Modeling Studies and Environmental Monitoring Laboratory (LEMMA). This study proposes a new training model for cataract surgery, through phacoemulsification. Aspects of materials used and sequential procedures of its construction were described. Since the training model is still on the validation phase, where veterinarians surgeons, specialized in veterinary ophthalmology, will test the model and answer Likert questionnaires for its evaluation, results will be reported in the following stages.

**Keywords:** Veterinary ophthalmology. Tonometry. Surgical model. Alternative teaching techniques. Dogs. Phacoemulsification.



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## 1 GENERAL INTRODUCTION

The measurement of intraocular pressure (IOP) is an important diagnostic test during an ophthalmic clinical examination (GÖRIG et al., 2006; THOMPSON-HOM & GERDING, 2012), and essential for diagnosis and monitoring glaucomatous eyes (GÖRIG et al., 2006).

Accuracy of IOP measurements in normal eyes and diseased eyes with several conditions, including glaucoma, uveitis, corneal disease, as well as during post-operative conditions, where been extensively evaluated using applanation tonometry (THOMPSON-HOM & GERDING, 2012), which since the last two decades, have been gradually replaced by rebound tonometers.

The rebound tonometer determines IOP values, by propelling a replaceable, magnetized probe at the cornea at a set speed; measuring the deceleration and converting this measurement to units of pressure (mmHg). The higher the IOP resultant, the shorter is the duration of the impact with the cornea. The average IOP of six contacts with the cornea is shown in a liquid crystal display, with automatic disregard of data outside the standard deviation range (PEREIRA et al., 2011; THOMPSON-HOM & GERDING, 2012).

Numerous studies were published focused in validating rebound tonometers, in different species, demonstrating that rebound tonometry can monitor IOP accurately and reproducibly (WANG et al., 2005; PEASE et al., 2006; MCLELLAN et al., 2012; ZHANG et al., 2014). However, handheld devices, permits small movements of the instrument during the IOP values acquisition, especially at the time when the trigger is activated, which may lead to additional errors (WANG et al., 2005). Moreover, rebound tonometry accurate IOP measurements relies on a horizontal orientation of the probe, and handheld operation cannot always assure such orientation (WANG et al., 2005; DE OLIVEIRA et al., 2018).

In the presented study, in chapter I, the main objective is to verify whether the tonometer TonoVet® (Icare, Finland Oy) designated variation, of 4 to 8 mm probe-cornea distance, have an effect on IOP values.

Several inanimate models, of high fidelity and low fidelity, have been created for the purpose of teaching and training (REZNICK & MACRAE, 2006; FOX et al., 2013; CAPILÉ et al., 2015; NIBBLETT et al., 2015; YOO et al., 2016), as a natural response to an notorious increased concern about animal welfare and quality of life (SCALESE & ISSENBERG, 2005; NIBBLETT et al., 2015).



On the other hand, according to author's knowledge, there are no reports of commercially available models for the simulation of cataract surgery in veterinary medicine, nor inanimate models, nor virtual simulators.

In the chapter 2, we present a study with the objective to create a low cost, reusable, high-fidelity canine cataractous eye model for phacoemulsification surgery training. Different materials were tested for each part of the model, which is still in the validation phase, and will soon be submitted for validation.

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## 2 CHAPTER 1 - INTRAOCULAR PRESSURE MEASUREMENTS USING THE TONOVET® REBOUND TONOMETER: REPEATABILITY AND INFLUENCE OF THE TONOMETER-CORNEA DISTANCE

### 2.1 ABSTRACT

Rebound tonometry with TonoVet® (Icare, Finland Oy) is extensively used for measuring intraocular pressure (IOP) in routine ophthalmic exam of small animals. The manufacturer designates a variation of 4 to 8 mm in distance from the probe to the eye. However, to date, there are no studies proving whether these different distances have an effect on IOP values. The first objective of this study was to determine intraobserver and interobserver agreement, between repeated measurements made by three different observers, using the TonoVet® in 16 eyes of 32 beagles. Intraobserver evaluation showed mostly no significant differences between the first, second and third measurements of the same observer (observer A  $p=0.06$ , observer B  $p=0.82$ , observer C  $p=0.62$ ), but there was significant difference in interobserver evaluation ( $p=0.03$ ). The second goal was to investigate potential differences on IOP values obtained with three different distances (4, 6 and 8 mm) between the equipment and the corneal surface, in 15 anesthetized Wistar rats and 32 clinically healthy conscious beagles. The original TonoVet® collar was substituted for three different sized polylactide plastic spacer collars, which provided a 4-mm (group S), 6-mm (group M) and 8-mm (group L) distance from the cornea. In dogs, the mean  $\pm$  SD IOP obtained were  $20.69 \pm 4.14$  mmHg at 8-mm,  $18.35 \pm 3.68$  at 6-mm, and  $17.12 \pm 3.76$  at 4-mm distance. In rats the median IOP was 11 mmHg at 8-mm, at 6mm 10 mmHg at 6-mm and 8 mmHg at 4-mm distance. There was a significant difference in IOPs comparing L vs M vs S in dogs and rats ( $p<0.01$ ). These results demonstrate that different distances used, from the probe to the cornea, can result in small but statistically significant difference in the IOP values.

Keywords: Dog. Intraocular pressure. Distance. Rat. Rebound tonometry. Tonovet®.

### 2.2 INTRODUCTION

Rebound tonometry using TonoVet® and more recently TonoVet Plus® (Icare, Finland Oy) have become increasingly popular during the last decade for measuring intraocular pressure (IOP) in animals, including domestic, laboratory, as well as exotic and wildlife species (KNOLLINGER et al., 2005; REUTER et al., 2010; RUSANEN et al., 2010; NAGATA et al., 2011; SELLERI et al., 2012; SLACK et al., 2012; THOMPSON-HOM & GERDING, 2012; ZHANG et al., 2014; VON SPIESSEN et al., 2015; SOMMA, et al., 2017; DE OLIVEIRA et al., 2018; DUBICANAC et al., 2018; SNYDER et al., 2018), and humans, especially children (DAVIES et al., 2006; GANDHI et al., 2012). Considering that rebound tonometry allows a brief contact between the probe and corneal surface, corneal anesthesia is usually not necessary. It is the preferred method over contact tonometry, which is not well tolerated, particularly by children and most unsedated animals (KONTIOLA et al., 2001; CHUI et al., 2008; MCLELLAN et al., 2012; DOSUNMU et al., 2014).

Besides being a non-traumatic diagnostic tool, the TonoVet<sup>®</sup> possesses some interesting features that may be considered advantageous during IOP acquisition in animals. It is light and portable, easy to use, requires minimal patient restraint and provides a species-specific calibration: dogs/cats and horses, in TonoVet<sup>®</sup>, and also lapines, in the Tonovet<sup>®</sup> Plus. Both TonoVet<sup>®</sup> and TonoVet Plus<sup>®</sup> have a smaller probe tip when compared to applanation tonometry, such as the Tono-Pen XL or Avia (Reicher, Inc., Depew, NY), which facilitates the IOP estimation in smaller animal species (KNOLLINGER et al., 2005; LEIVA et al., 2006; PRASHAR et al., 2007). On the other hand, a potential disadvantage of the TonoVet<sup>®</sup> is the fact that the patient's eyes must be positioned more or less parallel to the floor, with the tonometer probe oriented horizontally; in general, this is not the case for applanation tonometry, which allows variations in positioning (KNOLLINGER et al., 2005).

Many studies focused on testing reproducibility and IOP results, between tonometry devices with different technologies, are easily found in both medical (KNIESTEDT et al., 2005; BRUSINI et al., 2006; GARCIA-RESUA et al., 2006; MARTINEZ-DE-LA-CASA et al., 2006; PAKROU et al., 2008) and veterinary literature (LEIVA et al., 2006; JEONG et al., 2007; NAGATA et al., 2011; PARK et al., 2011; PEREIRA et al., 2011; ANDRADE et al., 2012).

IOP values obtained by rebound tonometry may suffer interference from the probe angle when touching corneal surface in dogs (DE OLIVEIRA et al., 2018), but apparently not in humans (CHUI et al., 2008; BEASLEY et al., 2013) and chickens (PRASHAR et al., 2007). However, to the best of our knowledge, the effect of probe-corneal surface distance has not yet been studied in dogs. The TonoVet<sup>®</sup> user manual recommends a distance of 4-8 mm between the probe and corneal surface (Icare<sup>®</sup> TonoVet<sup>®</sup> tonometer TV01 MANUAL, 2013). The two objectives of this study were: 1) To determine intraobserver and interobserver agreement, between repeated measurements made by three different observers using TonoVet<sup>®</sup>; 2) to investigate the effect of probe-corneal surface distance, within the recommended range, on IOP measurements in rats and dogs.

## 2.3 MATERIALS AND METHODS

All procedures were approved by the Animal Use Committee of Federal University of Paraná and conducted in accordance with the ARVO Statement for the Use of Animals in Ophthalmic and Vision Research. Complete physical and ophthalmic evaluations were performed, in order to assure that only healthy animals would be included in the study. Special attention was given to exclude corneal abnormalities because of their potential effect on IOP

readings (KNIESTEDT et al., 2005; PRASHAR et al., 2007). This study was performed in three parts: measurement of intraocular pressure in Beagle dogs by three different observers, evaluation of the tonometer distance on intraocular pressure measurements in anesthetized rats, and evaluation of the tonometer distance on canine intraocular pressure measurements.

### 2.3.1 Measurement of intraocular pressure in Beagle dogs by three different observers

To determine interobserver variability with the TonoVet® (Icare®, Finland Oy, USA) in dogs, 16 healthy Beagles (8 intact females and 8 intact males), belonging to the Dog Nutrition Laboratory from the Federal University of Paraná (LENUCAN) were included in this part of the study.

Three different experienced observers performed rebound tonometry measurements with the TonoVet®, on awake, minimally restrained dogs, at an estimated probe-central cornea distance of about 4-8 mm to the central cornea, in accordance with manufacture's recommendations. Three IOP values were collected in sequence. Results showing an error bar at TonoVet® display, at any level, were immediately discarded. Calibration was used in the default setting "do", indicated for dogs. All measurements were made in different days for each observer, between 4:00 and 8:00 PM in order to avoid the effect of daytime variation on the IOP (GELATT & MACKAY, 1998; PRASHAR et al., 2007; RAJAEI et al., 2018).

### 2.3.2 Evaluation of the tonometer distance on intraocular pressure measurements in anesthetized rats

Fifteen clinically normal 3-month-old male Wistar rats, belonging to Pequeno Príncipe Complex animal research facility, were included in the experiment. Only the left eyes were examined.

A single experienced examiner performed all IOP measurements, as an attempt to standardize the measurements (GATON et al., 2010), and a different observer was responsible to read and note the IOP readings to minimize potential bias. All measurements were taken between 9:00 AM and 12:00 PM in order to minimize any diurnal effects on IOPs (GELATT & MACKAY, 1998; PRASHAR et al., 2007; RAJAEI et al., 2018).

The original TonoVet® collar (Fig.1) was substituted for three different sized spacer collars, especially designed and made with polylactide (PLA) plastic in a 3D printer (3D Cloner HD, Marechal Cândido Rondon, PR, Brazil - Produteca, Curitiba, PR, Brazil). The spacer

collars were carefully manufactured so that the surface of contact with the cornea was smooth; nevertheless, a conscious effort was made not to touch the cornea with it. The total distance traveled to the corneal surface by the TonoVet<sup>®</sup> probe inside each of the three different spacers would fall in the range recommended by the manufacturer (4 to 8mm). The green spacer (“S-small”), measuring 15 mm in total length, provided an internal probe-corneal surface travel distance of 4-mm (Fig. 2). The yellow spacer (“M-medium”), measuring 17 mm in total length, provided a 6-mm probe-corneal surface distance. Finally, the red one (“L-large”), measuring 19 mm in length, provided an 8-mm distance from the cornea.

For each spacer, three IOP values were obtained in sequence for each eye, with calibration settings in default “do”. Each IOP value shown on the TonoVet<sup>®</sup> liquid crystal display corresponds to the mean of six successive individual tonometry readings. Results showing an error bar at TonoVet<sup>®</sup> display, at any level, were discarded, which means that only values with deviation equal or less than 1 mmHg were used (Icare<sup>®</sup> TONOVET tonometer TV01 MANUAL, 2013). A one-minute time interval was respected between readings with different spacer. In order to avoid the introduction of a systematic error, each spacer was numbered (1-S, 2-M, 3-L) and used in random order in each animal, using the RANDBETWEEN function of Microsoft Excel 2007 (One Microsoft Way, Redmond, Washington, USA).

Anesthesia was induced with isoflurane administered by a nose cone mask at 5% with an oxygen flow rate of 1 L/min. After animal’s loss of the righting reflex, isoflurane was adjusted to 1.5% and the flow rate reduced to 500 mL/min. At the end of the evaluations, isoflurane was discontinued and the animals received oxygen flow until they were totally recovered from anesthesia. The animals were positioned in sternal recumbency on a platform with the eye adjacent to the tonometer tip, and a metallic support clip was used to hold the tonometer, as done and proposed by Wang et al. (2005) (Fig. 3). The tonometer probe tip was perpendicular to the central cornea and fixed at 1 mm of distance from the corneal surface, measured previously by caliper, so that the final desired distances from the cornea were achieved, by discounting the probe tip size (Fig. 4). The eyelids were kept open with a blepharostat.

### 2.3.3 Evaluation of the tonometer distance on canine intraocular pressure measurements

A total of 32 clinically healthy Beagles (17 males and 15 females), aging from 2-14 years were examined. These included 16 client-owned dogs and 16 dogs belonging to the Dog Nutrition Laboratory of the Federal University of Paraná Paraná (LENUCAN), totaling 32 left eyes. Dog owners signed a consent form before the procedure.

A single experienced examiner performed all IOP measurements, and a different observer was responsible to read and record the IOP readings to minimize potential bias. All measurements were made between 4:00 PM and 8:00 PM in order to avoid the effect of daytime variation on the IOP (GELATT & MACKAY, 1998; PRASHAR et al., 2007; RAJAEI et al., 2018).

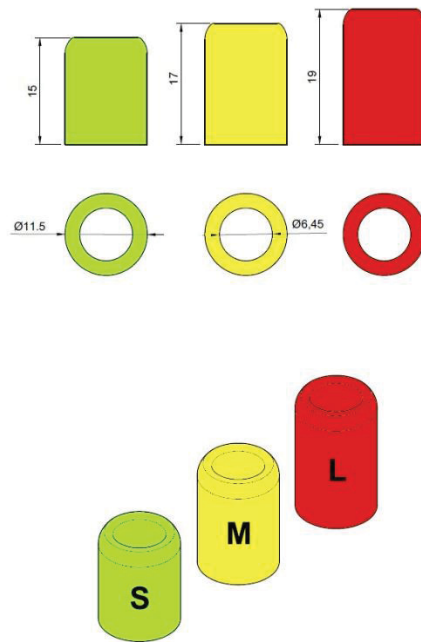
The same procedures were performed on awake, minimally restrained dogs as previously performed on anesthetized rats and described above (Fig. 5). An assistant was responsible for visually verifying the distance between the end of the spacer and the cornea.

In an attempt to prevent the introduction of a systematic error, IOPs were measured by changing the spacers in a given order (S, M and L) in the first 16 animals, and in inverse order (L, M and S) in the remaining 16 animals.



**Figure 1.** Photograph of the rebound tonometer, TonoVet® Icare, showing the regular collar piece position.

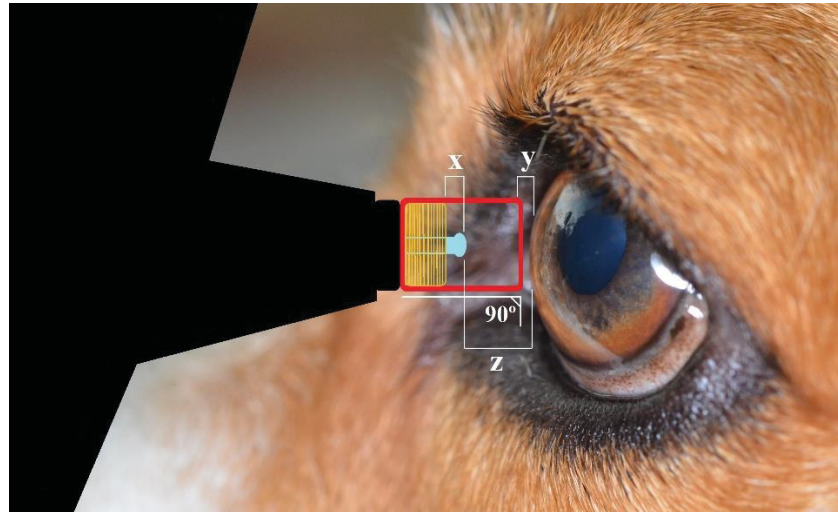




**Figure 2.** Illustration showing the different sized spacer collars, with measures in millimeters.



**Figure 3.** Representative, photograph depicting one of the rats studied in sternal recumbency. A metallic support clip that was used to hold the tonometer with the spacer at a fixed 1-mm distance from the corneal surface.



**Figure 4.** Scheme depicting the fixed probe-cornea surface distances obtained with the spacers. The probe was at a  $90^\circ$  angle to the corneal surface, with  $x = y = 1\text{ mm}$  and  $z = 8\text{ mm}$  (L),  $6\text{ mm}$  (M) or  $4\text{ mm}$  (S), respectively.



**Figure 5.** Representative photograph depicting the positioning of the dog at IOP measurement with the “L” spacer collar.

#### 2.3.4 Statistical analyses

A Shapiro-Wilk test was used to test data normality.

In “Evaluation of the tonometer distance on intraocular pressure measurements in anesthetized rats” and “Measurement of intraocular pressure in Beagle dogs by three different observers” data were not normally distributed. IOPs were analyzed and compared using a Friedman’s test and Wilcoxon signed rank test. Pearson’s correlation and linear regression were used to establish the strength and direction of association as well as a linear approach to model the relationship between the two ranked variables (IOP and distance).

In “Evaluation of the tonometer distance on canine intraocular pressure measurements” data were normally distributed. Hence, IOPs from three groups (L vs M vs S) were analyzed using repeated-measures ANOVA and paired t test was used for pairwise comparison (L vs M, M vs S and L vs S). Pearson’s correlation test and simple linear regression were also applied.

P values < 0.05 were considered significant. The software used for statistical analyses was SigmaPlot 12.5 (Systat Software, Inc., San Jose, CA, USA). Limits of agreement between measurements made with the different distance were expressed at the 95% level, according to Bland and Altman (1986).

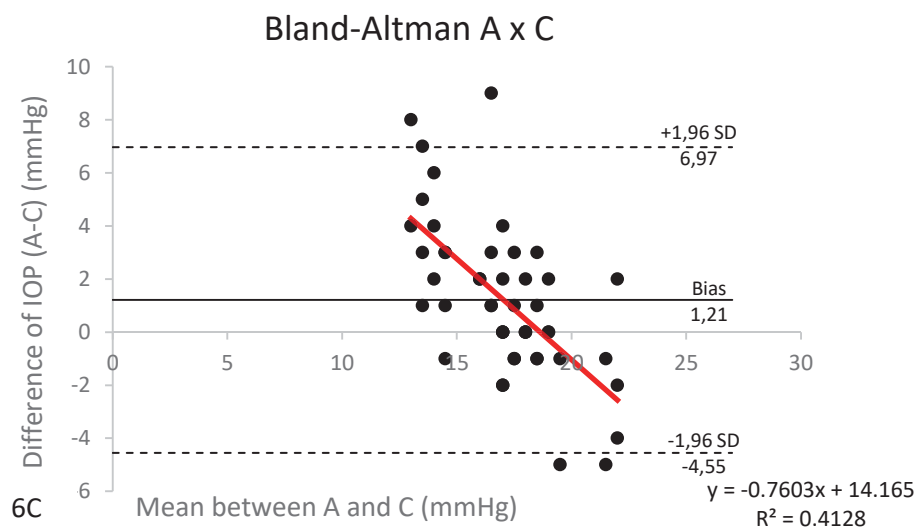
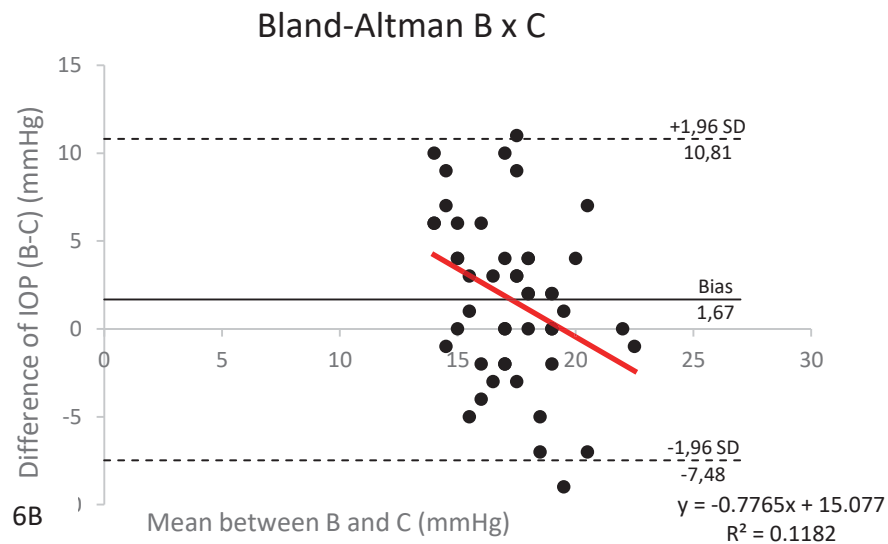
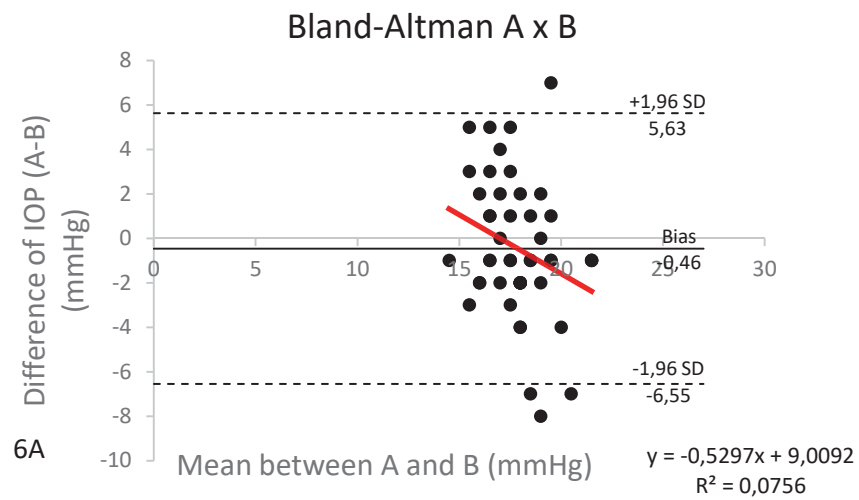
## 2.4 RESULTS

### 2.4.1 Measurement of intraocular pressure in Beagle dogs by three different observers

There was an overall weak significant difference between the three observers ( $P=0.03$ ), as well as between individual observers by pairwise comparison, observer A vs observer C ( $P<0.01$ ) and observer B vs observer C ( $P=0.02$ ); however, there was no statistical difference between observer A vs observer B ( $P=0.29$ ). Median and interquartile range of the three groups are shown in Table 1. Fig. 6 shows the Bland-Altman plots for comparison between observers, with a 95% confidence interval.

**Table 1.** IOP median, IQR and range (mmHg), of three different observers: A, B and C.

	A	B	C
Median	17	18	17
Interquartile range (IQR)	2,25	3,25	4,75
Range	9	11	15



**Figure 6.** Bland-Altman plots showing the lack of agreement between IOPs measured by observers B vs C and A vs C with TonoVet®, with higher values of differences between measures and higher bias. Vertical axis shows the difference in IOPs, and the horizontal axis shows the means between the groups. The dashed lines shows the limits of agreement of 95%. The full line is representative of the means of the differences and the dotted red line is the linear regression with the equation and  $R^2$ , determination coefficient values.

No significant differences were found between first and second IOP measurements, as well as between first and third measurements of observer A, B and C (Table 2). A significant difference was found between the second and the third measurements of observer A, but not of observers B and C.

**Table 2.** Statistical analysis of comparison between repeated IOP measurements made by three different observers.

Statistical analysis of comparison between repeated IOP measurements			
	Observer A	Observer B	Observer C
Wilcoxon test			
IOP1xIOP2	P=0.35	P=0.70	P=0.98
IOP2xIOP3	P=0.01	P=0.53	P=0.20
IOP1xIOP3	P=0.31	P=0.64	P=0.33
Friedman test			
IOP1xIOP2xIOP3	P=0.06	P=0.82	P=0.62

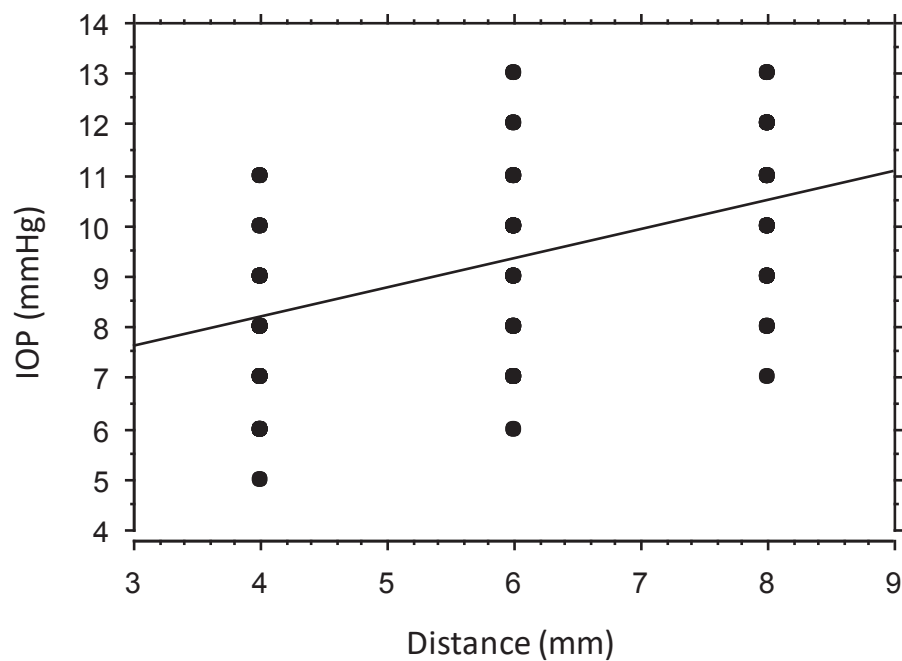
#### 2.4.2 Evaluation of the tonometer distance on intraocular pressure measurements in anesthetized rats

Data obtained in the population used in this study was not normally distributed according Shapiro Wilk test.

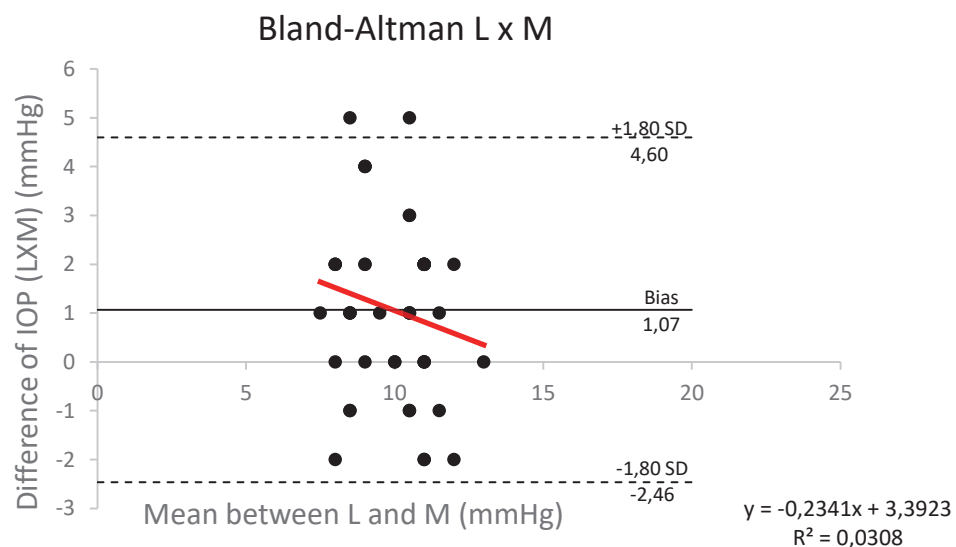
There was an overall significant statistical difference between IOP measurements at the three different probe-cornea distances ( $P<0.01$ ); but also by pairwise comparisons, L vs M ( $P<0.01$ ), L vs S ( $P<0.01$ ), and M vs S ( $P<0.01$ ), respectively. Median and interquartile range of the three groups are shown in Table 3. Linear regression graphic and function of IOP vs probe-cornea distance are presented on a column chart (Fig. 7). A moderate positive correlation between distance and IOP ( $r = 0.51$ ) was observed on Pearson's correlation. Linear regression function was  $Y = 5.915 + 0.572 \cdot X$ , were Y is IOP and X is the probe-cornea distance, and the coefficient of determination  $R^2 = 0.26$  Fig. 8 shows the Bland-Altman plots for comparison between measurements in different distances, with a 95% confidence interval.

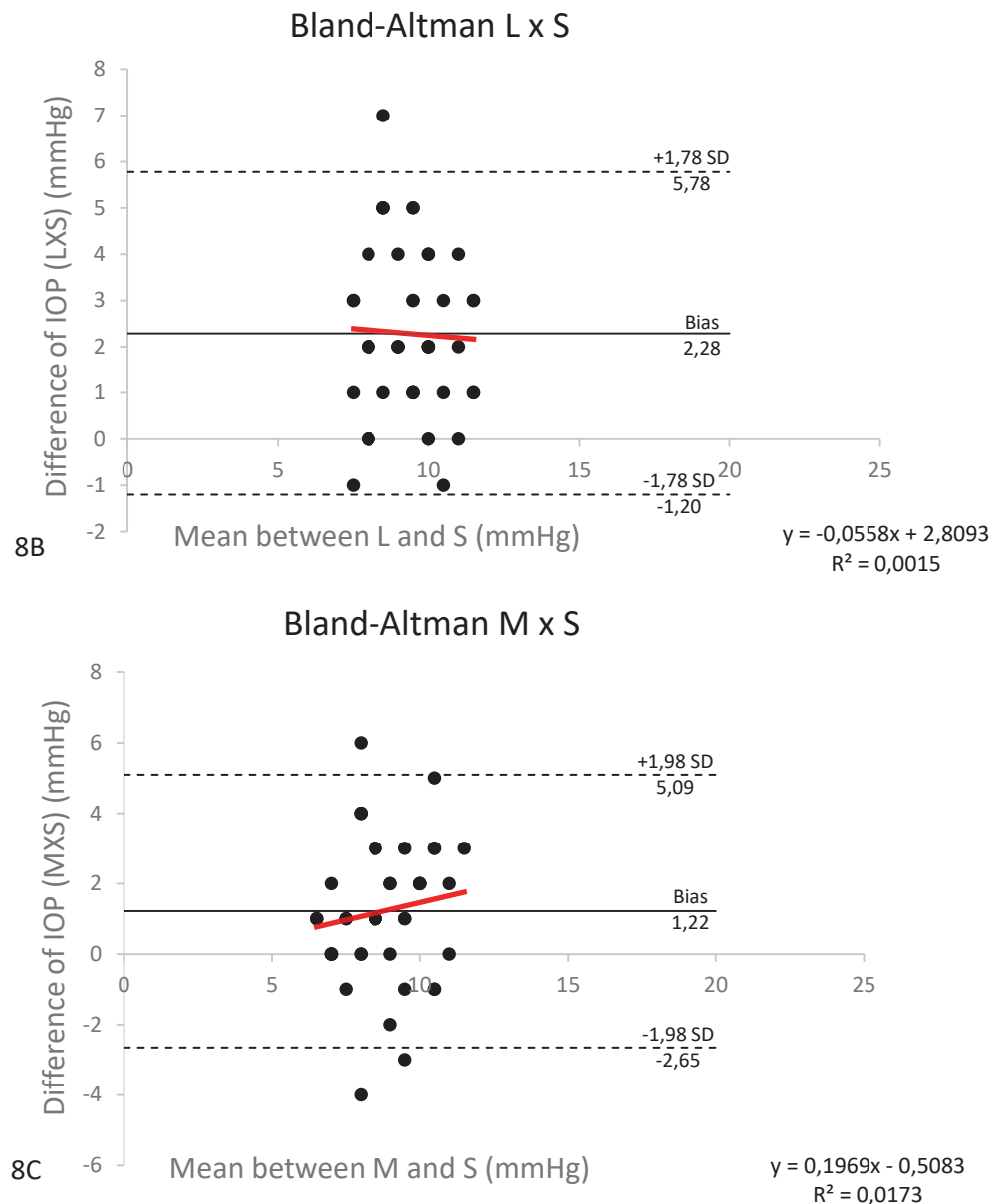
**Table 3.** IOP median, IQR and range (mmHg) of 3 different distances from the probe to the cornea in rats (L=8mm, M=6mm, S=4mm).

	L	M	S
Median	11	10	8
Interquartile range (IQR)	3	3	2
Range	6	7	6



**Figure 7.** Linear regression graphic and function of IOP (Y axis) vs probe-cornea distance (X axis) in rats.





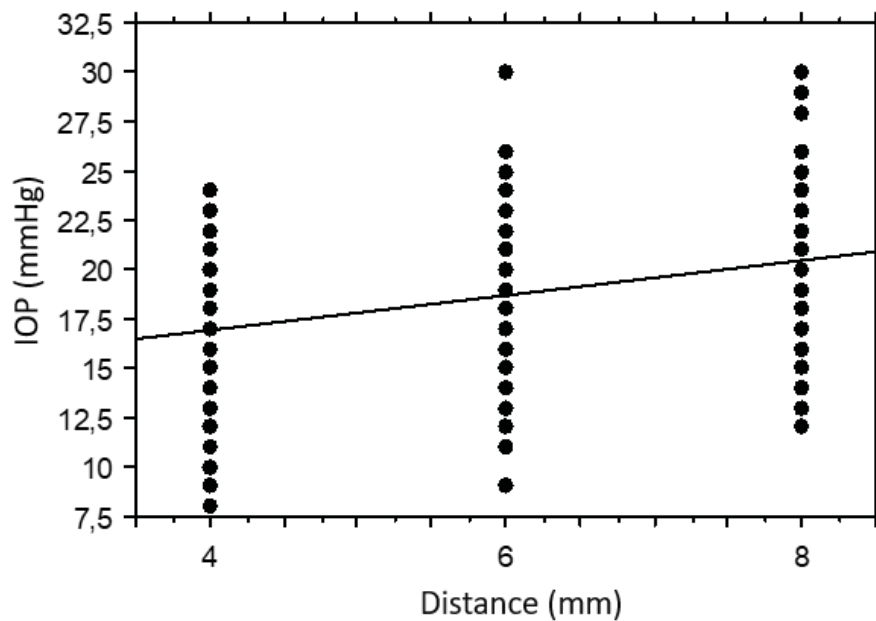
**Figure 8.** Bland-Altman plots showing the lack of agreement between IOPs measured at different distances with TonoVet®, with bias ranging from 1,07 to 2,28 mmHg. Vertical axis shows the difference in IOP readings, and the horizontal axis shows the means between the groups. The dashed lines shows the limits of agreement of 95%. The full line is representative of the means of the differences and the dotted red line is the linear regression with the equation and  $R^2$ , determination coefficient values.

#### 2.4.3 Evaluation of the tonometer distance on canine intraocular pressure measurements

Probe-cornea distance did significantly affect IOP ( $P < 0.01$ ). There was an overall significant difference in IOPs as a function of distance, as well as by pairwise comparison: L vs M ( $P < 0.01$ ), L vs S ( $P < 0.01$ ) and M vs S ( $P < 0.01$ ), respectively. A weak positive correlation between distance and IOP ( $r = 0.35$ ) was observed by Pearson's correlation. Linear regression



function was  $Y = 13.378 + 0.891 \cdot X$  where Y is IOP and X is the distance of probe from corneal surface, and the coefficient of determination  $R^2 = 0.12$  (Fig. 9).

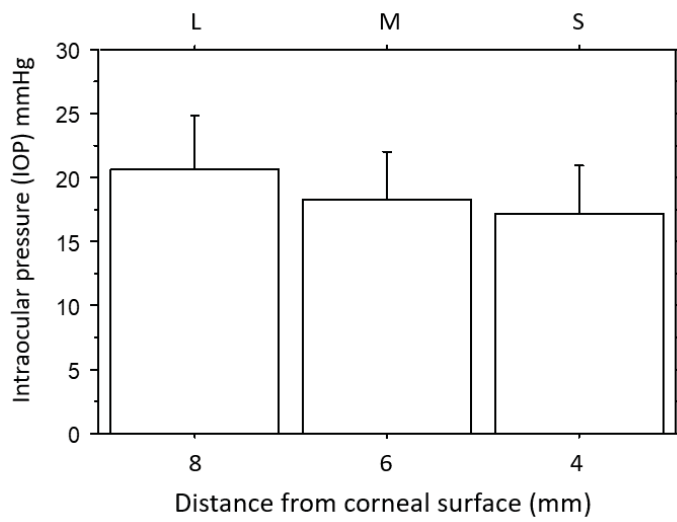


**Figure 9.** Linear regression graphic and function of IOP (Y axis) vs probe-cornea distance (X axis) in dogs.

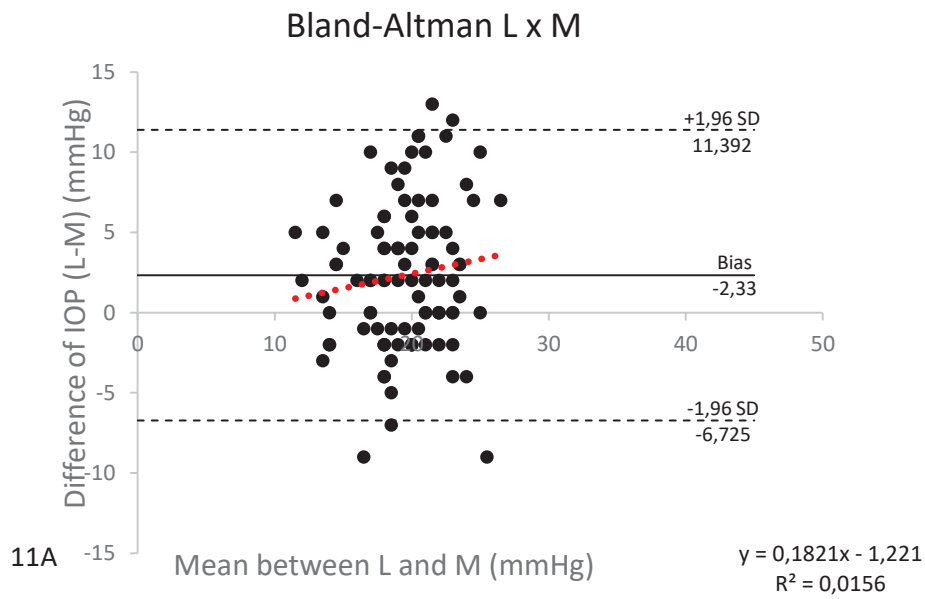
Means and standard deviations for each probe-cornea distance are described in Table 4 and column chart (Fig. 10), and Fig. 11 shows the Bland-Altman plots for comparison between measurements in different distances, with a 95% confidence interval.

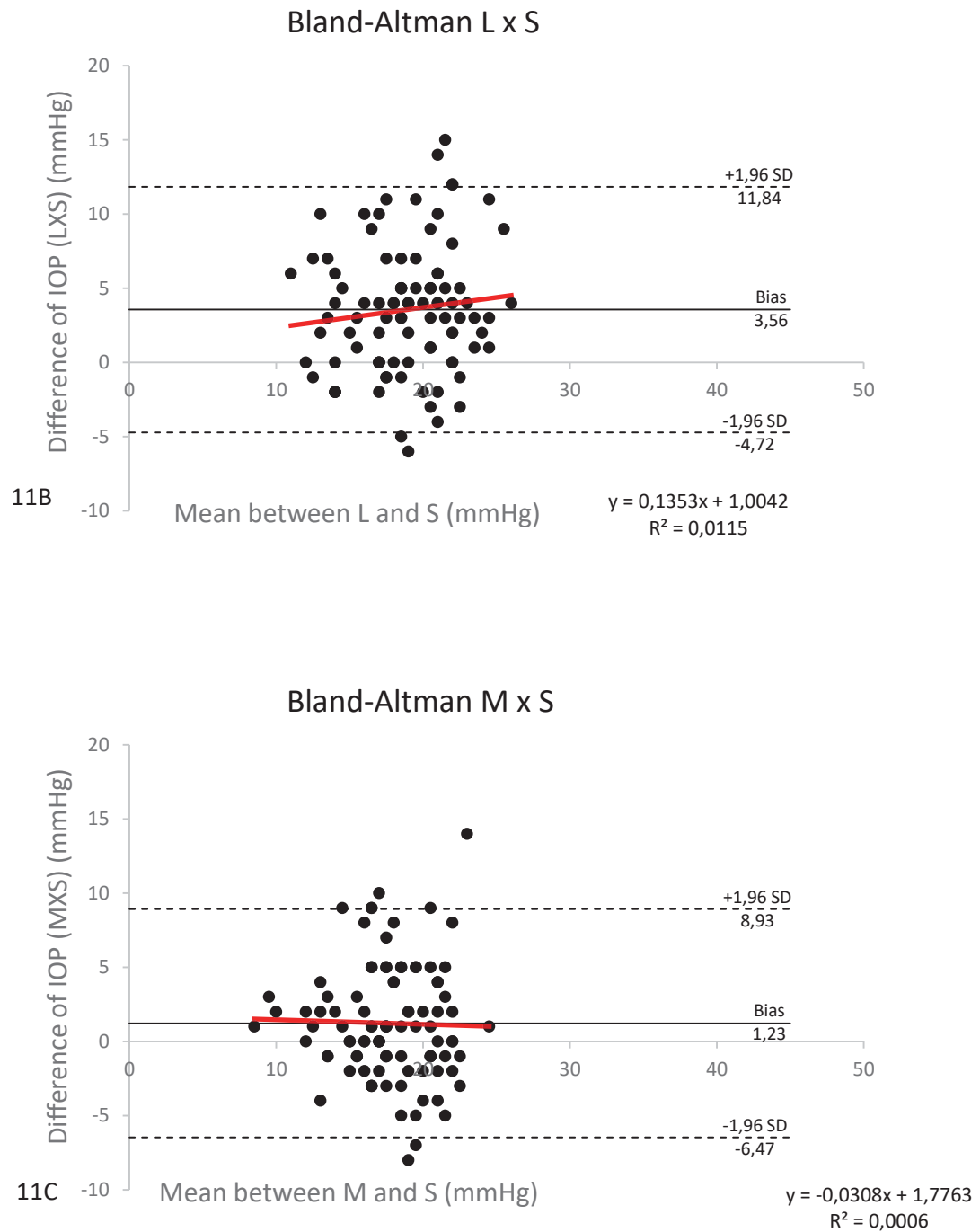
**Table 4.** IOP means and standard deviation of groups L, M and S.

	Mean (mmHg)	Std. Dev. (mmHg)
L	20.69	4.14
M	18.35	3.68
S	17.12	3.76



**Figure 10.** Column chart showing means and standard deviations of IOPs measured with TonoVet® at different probe-cornea distances.





**Figure 11.** Bland-Altman plots showing the lack of agreement between IOPs measured at different distances with TonoVet®, with bias ranging from -2.33 to 3.56 mmHg. Vertical axis shows the difference in IOP readings, and the horizontal axis shows the means between the groups. The dashed lines shows the limits of agreement of 95%. The full line is representative of the means of the differences and the dotted red line is the linear regression with the equation and  $R^2$ , determination coefficient values.

## 2.5 DISCUSSION

Tonometry using the Tonovet® was well tolerated by all dogs, even without the use of ocular surface anesthesia. This is consistent with previous reports in dogs and horses (KNOLLINGER et al., 2005), cats (RUSANEN et al., 2010), owls (JEONG et al., 2007), chickens (PRASHAR et al., 2007), rats and mice (WANG et al., 2005), chinchillas (SNYDER et al., 2018) and humans (PAKROU et al., 2008).

The manufacturer recommends a range of 4-8 mm distance between Tonovet® probe and ocular surface. It could be assumed that there is no significant variation in IOP readings within this range of probe-cornea distance. However, in the present study, the variation in distance did affect the IOP results. In contrast, Prashar et al. (2007) found no statistically difference for measurements obtained at different distances (3, 4 and 5mm) on enucleated chicken eyes. Kontiola et al. (2001), showed in Wistar rats that IOP measurements were relatively unaffected by the initial distance of the probe from the cornea, between 3 and 5 mm. A possible explanation for this is that in all these previous investigations only relatively small distances (3-5mm) from the probe to the corneal surface were tested. In order to find a true difference, a higher number of repetitions was probably needed. In the present investigation greater distances (4, 6 and 8 mm) were compared. Bigger probe-cornea distances the greater the observed differences in IOP, as it was possible to see in figures 7 and 9 in the linear regression graphics. Therefore, here it was possible to see the true data tendency.

The farther away from the cornea, the higher the IOP observed. This result could probably be attributed to Newton's second law,  $F = m \cdot a$  (GUNDLACH et al., 2007), which affirms that the acceleration (a) of an object as produced by a net force, is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object (m). Thus, force on an object is equal to the mass of the object multiplied by its acceleration. In this case, the probe had the same mass in all groups, but the acceleration was greater, as greater the distance, considering the electromagnetic propulsion of the probe as a simple harmonic motion.

During the measurements, an important factor was observed; the groups using the “L spacer” presented the measures of dispersion (interquartile ranges and standard deviation) as well as largest number of measures discarded due to the occurrence of error bars in the display. This may have occurred because the distance defined by the collar “L” may be close to the maximum recommended distance reached by the probe, and thus the occurrence of a minimal

angulation would preclude the reading by preventing the contact of the probe with the cornea.

Since movement and position of the patient and the variation in restraining technique have been proposed to interfere in IOP acquisition (KLEIN et al., 2011; MCLELLAN et al., 2012), the first part of the present study was conducted on anesthetized rats. The second part of the study was performed on awake dogs, mimicking a clinical setting, but also with conscious efforts to control these factors. However, a limitation of this study was the absence of manometric IOP evaluation. It could be enlightening, by pointing at which distance the TonoVet® IOP readings are the most accurate (WANG et al., 2005; GÖRIG et al., 2006; MARTINEZ-DE-LA-CASA et al., 2006; RUSANEN et al., 2010; PEREIRA et al., 2011; GANDHI et al., 2012; SNYDER et al., 2018).

In the first part of the study, statistical differences were observed between IOPs measurements made by different observers on the same animals. This is in disagreement with McLellan et al. (2012), who reported no significant difference between TonoVet® readings of two observers in cats. Our findings showed difference between the three observers when compared together and between observer A and C and B and C, but no significant difference between observer A and B. This difference occasionally found between observers might be partially attributed to different distances naturally used by each observer. The distance used to make the IOP measurements can diverge normally from person to person, although tends to be constant in intraobserver evaluation, with mostly no significant changes comparing the first, second and third measurements of the same observer, as seen in table 2.

In light of our findings, the authors believe that on research settings the tonometer-cornea distance should be, preferably, a known variable and standardized in order to compare results from different investigations. Keeping the same tonometer-cornea distance prior to IOP acquisition in a clinical setting would be much harder. Nevertheless, knowledge of all the possible variables might contribute to keep IOP acquisition more accurate by the examiner. It is known that especially for patients with glaucoma, even small changes in IOP may have clinical implications on risk of glaucoma progression, raising the importance of a precise technique (HEIJL et al., 2002; WANG et al., 2005; GATON et al. 2010), which brings the importance of studies like this being done on glaucoma patients in the future. We also believe that early diagnosis of this rapidly evolving disease is also important for healthy patients.

Concerning the distance of the tonometer from the eye, it is obviously more difficult to keep the distance unchanged in a veterinary medicine then in a medicine clinical setting. The Icare® PRO, used in medical ophthalmology has an adjustable forehead support that allows an

accurate measurement distance and alignment (KIM et al., 2013). Because of larger variations in canine compared to human facial anatomy, it is more difficult to maintain a stable probe-cornea distance in dogs. The latest version of Icare® for veterinary ophthalmology, the Icare TonoVetPlus® (Icare, Finland Oy), has a similar measuring support and measuring support adjusting wheel. Nonetheless, even in its instruction manual, this measuring support does not touch the forehead of dog and cat in illustrations, and there are no instructions concerning the use of this accessory (Icare® TONOVET Plus TV011-002, Instruction Manual, 2016).

In the scope of research, the attempt to standardize the distance used for each experiment would be valuable, since even small variations can significantly change the results, as proved here. Nevertheless, despite the vast literature on the subject, only few articles quote the exact distance that was applied from the probe to the cornea in their studies (MCLELLAN et. al., 2012; ZHANG et al., 2014).

## 2.6 CONCLUSION

The present study showed that there is a small positive yet significant correlation between the distance of the Tonovet® tonometer probe from the corneal surface and the IOP value, even within the range of distances designated by the manufacturer. Therefore, in order to ensure repeatability in research settings we recommend indicating the distance at which the probe was kept from the corneal surface.

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### 3 CHAPTER 2 - DEVELOPMENT OF A CANINE CATARACTOUS EYEBALL MODEL FOR PHACOEMULSIFICATION TRAINING

#### 3.1 ABSTRACT

A canine cataractous eyeball model was developed to help veterinary ophthalmologists to train phacoemulsification surgery in order to improve their performance in the main steps of the surgical technique expectantly reducing intraoperative and postoperative complication rates on real patients. This new model has reusable parts (sclera and iris), made with polylactide (PLA) plastic using a 3D printer, and disposable parts (cornea, capsule and lens), made of PVC plastic, Parafilm® (Bemis Company, Inc, Neenah, WI, USA) and beeswax, respectively. Parafilm® is a semi-transparent, flexible non-toxic, tasteless and odorless self-sealing thermoplastic film composed of a proprietary blend of waxes and polyolefins. This eye model was coupled on a closed-cell extruded polystyrene foam base and covered with a canine head mask to increase the level of fidelity. In the second part of this project, five experienced veterinary ophthalmologists will perform phacoemulsification using this model and will complete a survey to validate the model. This novel canine surgical model shows promising as a training tool for the phacoemulsification technique.

**Keywords:** Phacoemulsification. Model validation. Teaching model. Clinical skills. Skills assessment.

#### 3.2 INTRODUCTION

Cataract is an eye disease manifested by opacity of the fibers of the normally clear lens and/or its capsules, being the most common cause of visual loss and blindness in dogs worldwide (ADKINS & HENDRIX, 2003; GELATT & MACKAY, 2005; PARK et al., 2009).

Surgical therapy is the only definitive method of treatment of cataracts (ADKINS & HENDRIX 2003; LIM et al., 2011). Phacoemulsification technique was first performed by Charles David Kelman, in New York, in 1967 (SPITERI et al., 2010), and still is the most preferred surgical technique for animals and humans (BADOZA et al., 1999; RANDLEMAN et al., 2007).

Phacoemulsification is considered a "step-dependent" surgical procedure, in which problems in any of the initial steps, often hamper subsequent steps and lead to surgical failure and post-surgical complications (LIM et al., 2011; YULAN et al., 2013). Training for phacoemulsification also is "step-dependent", that is, acquiring surgical skill depends on the mastery of previous steps (MALAVAZZI et al. 2019).

In medicine, the teaching of phacoemulsification is considered a challenge. Significant advances in surgical ophthalmology therapies would require more time and attention of residents, but they have a static program of 3 years of residence training, usually

following an internship year (RANDLEMAN et al., 2007). Furthermore, patients have higher expectations (PRAKASH et al, 2009, SPITERI et al., 2010), due to an increasing access to technical information, and being not anesthetized during surgery (HOSLER et al., 2012).

This concern about training surgical skills to residents has been the subject of several scientific articles published in the last decades (SMITH, 2005; RANDLEMAN et al., 2007; CHOI & CHUNG, 2009; PRAKASH et al, 2009; SPITERI et al., 2010; KARA-JUNIOR, 2011; HOSLER et al., 2012; MCCANNEL et al., 2013; KAPLOWITZ et al., 2018).

Adequate supervision is essential to guarantee good surgical results, especially in the first 40 cases, to avoid greater complications rates (CARRICONDO et al., 2010). Regarding the level of technical capacity, Taravella et al. (2011) concluded, that the resident would equate to an experienced surgeon only after performing 75 surgeries, becoming faster and more independent. In Brazil, a resident of ophthalmology performs an average of 130 surgeries with modern equipment and under the guidance of an experienced surgeon, ranging from 80 to 400 procedures before starting in a private clinic (KARA-JUNIOR, 2011). In USA, The Residency Review Committee of the Accreditation Council for Graduate Medical Education increased the minimum number of cataract procedures performed by a resident as primary surgeon from 45 to 86 (RANDLEMAN et al., 2007), and in its last publication, of 2013, this number remains the same. In the United Kingdom and Ireland, a basic surgical trainees must have completed at least 50 such procedures before being able to commence higher surgical training (DOOLEY & O'BRIEN, 2006).

In the veterinary worldwide scenario, there are two major professional colleges namely the American College of Veterinary Ophthalmologists (ACVO), in the United States of America and the European College Veterinary Ophthalmologists (ECVO), which offer intern programs, residency programs, and only then, the possibility of becoming diplomate and practice the specialty. Consequently, the veterinarian must pass through a much longer and supervised path, with greater opportunities to improve his technique, before entering the private practice, similarly to medicine.

Otherwise, in Brazil, there are only two public institutions, the Federal University of Paraná and the Federal Rural University of Rio de Janeiro, which offer veterinary residency in the area of veterinary ophthalmology. In the private practice scenario, *lato sensu* specialization is the only option to a veterinarian become ophthalmologist. Currently, in most veterinary institutions, surgical instruction involves the use of live animals or cadavers (TEFERA et al., 2011), and specifically for cataract surgery, pig eyes. In these circumstances, the situation of veterinarian practical-surgical training is even more challenging, indicating the importance of

the development of a new teaching and training method, especially in the area of ophthalmic surgery, in order to contribute to the reduction of intra and postoperative complications in patients, resulting from the poor performance of newly specialized ophthalmologists that lack satisfactory training.

Henceforth, the ideal surgical training model would be the one closest to the anatomical reality of each species. Several inanimate models, of high fidelity and low fidelity, have been created for the purpose of teaching and training (REZNICK & MACRAE, 2006; FOX et al., 2013; CAPILÉ et al., 2015; NIBBLETT et al., 2015; YOO et al., 2016), just as there was an increase in concern for animal welfare (SCALESE & ISSENBERG, 2005; NIBBLETT et al., 2015). They are portable, reproducible, safe, available and more cost-effective than real models like live animals or cadavers (REZNICK & MACRAE, 2006).

In medicine, virtual simulators for surgical training of phacoemulsification are proposed to be a satisfactory method for surgical simulation (SAGAR et al., 1994; CHOI & CHUNG, 2009; HIKICHI et al., 2000; SELVANDER & ÅSMAN, 2012; MCCANNEL et al., 2013). With its use there is no animal rights concerns, there is easy availability, and still offer the possibility of storing the practice data, with measures and performance calculations for future comparisons, allowing individual practice, without the need for supervision, thus accelerating the learning curve and increasing decision-making and judgment capacity (CHOI & CHUNG, 2009). The major obstacle is its lower accessibility, due to its high cost. However, to date, in veterinary medicine, there are no reports of commercially available models for the simulation of cataract surgery, nor inanimate models, nor virtual simulators.

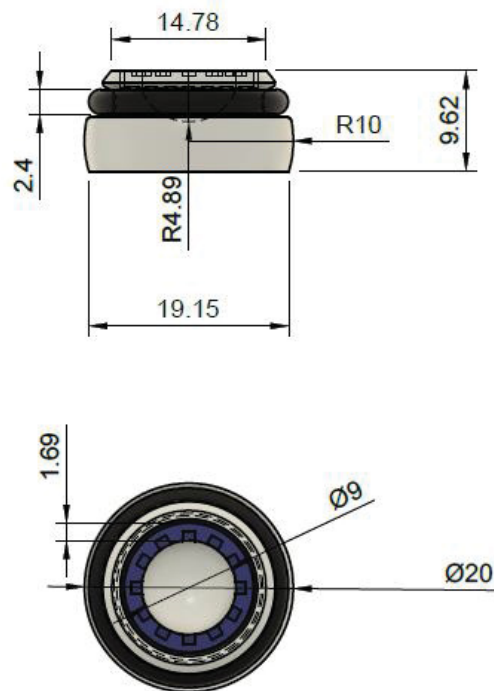
Therefore, the objectives of this study were to create a low cost, reusable, high-fidelity canine cataractous eye model, for the training of phacoemulsification surgery, aiming to become an alternative or even replace the most currently used techniques and to validate this model using face and content validity.

### 3.3 MATERIALS AND METHODS

#### 3.3.1 Model Construction

The eyeball model was designed and developed by the authors and a 3D company - Produteca (Batel, Curitiba-PR, Brazil), in multiple steps, during which diverse materials were tested. The final model construction was subdivided in parts: 1) The sclera and iris were made using a 3D printer (3D Cloner HD, Marechal Cândido Rondon, PR, Brazil), in polylactide

(PLA) plastic - reusable part; 2) The cornea was made with 0,3 mm grammage PVC plastic, by thermoforming (Fig. 2) - reusable part for phacoemulsification training or disposable if for corneal incisions training; 3) The lens was casted from beeswax, by melting it in a metal kitchen-measuring spoon, directly into the fire and placing it into the area intended for the model's lens - disposable part 4) The anterior capsule was represented by a strained parafilm piece - disposable part 5) The cornea was attached to the sclera with a 20 mm in diameter elastomer ring, normally used as a flexible joint in hydraulic circuits, allowing the creation of the anterior chamber - reusable part 6) The eye model was attached to a closed-cell extruded polystyrene foam base - reusable part (Fig.3A), and then, coupled to a dog head made with a dog mask, simulating a real patient - reusable part (Fig.3B).

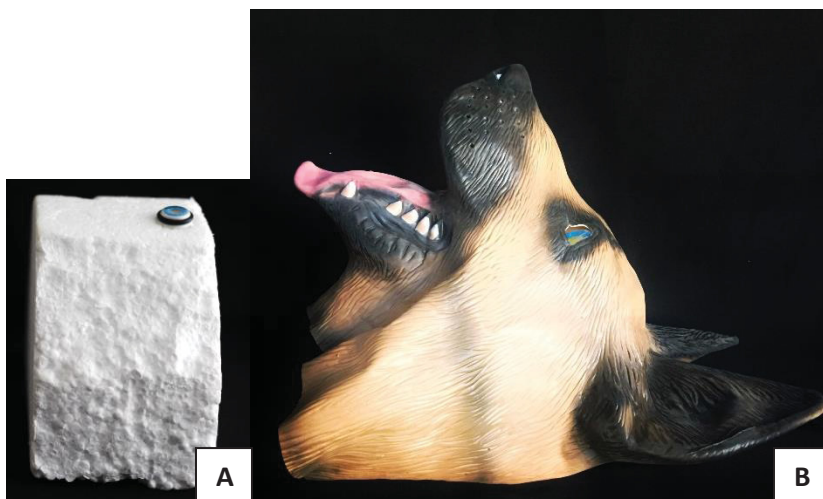


**Figure 1.** Eyeball model project with measures in millimeters.





**Figure 2.** Thermoforming process for construction of the cornea in 0,3 mm grammage PVC plastic.

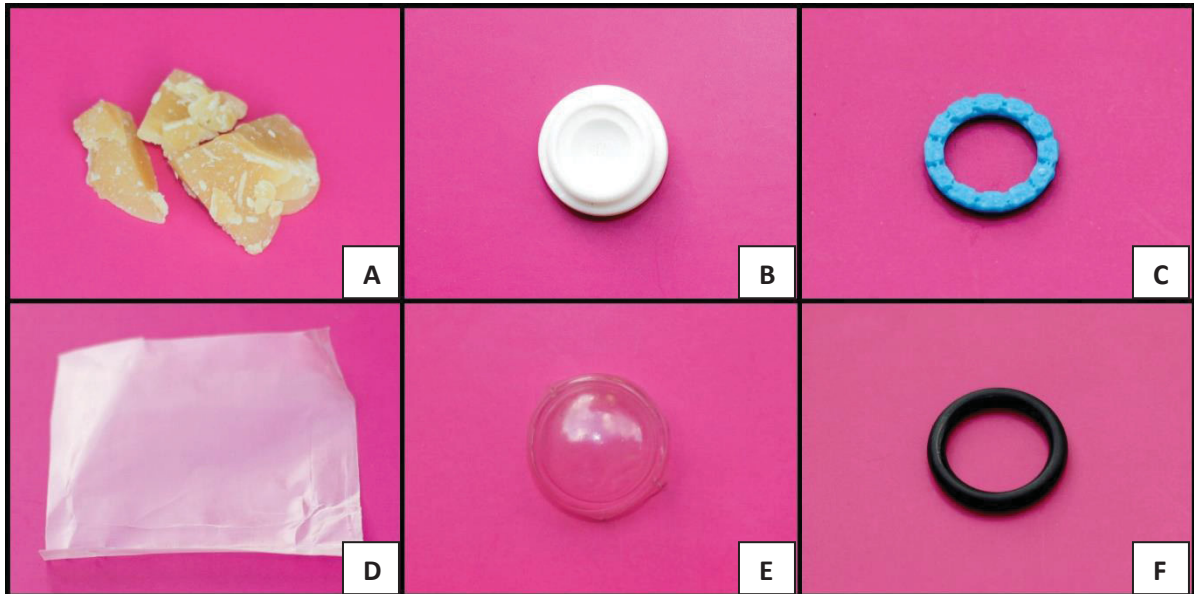


**Figure 3.** Eyeball model attached to a polystyrene foam base (3A) and then coupled to a dog head made with a dog mask (3B), to simulate the real patient.

For the assembly of the model for its use, we created an instruction manual:

#### ITENS (Fig. 4)

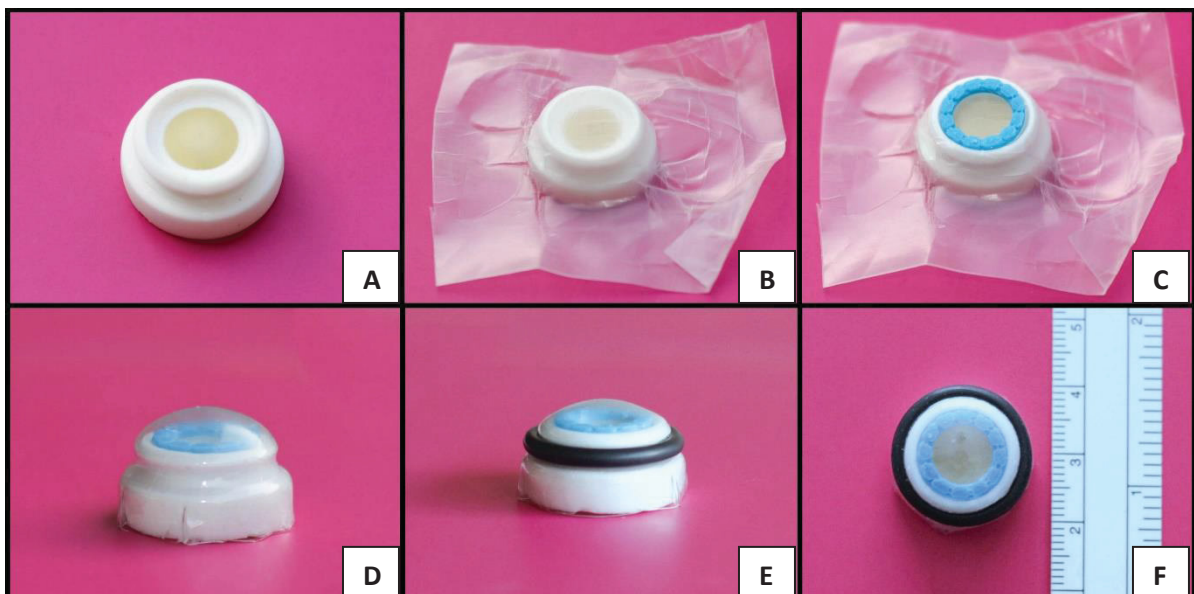
- A- Lens (Beewax) (4A)
- B- Sclera/Eyeball (PLA plastic) (4B)
- C- Iris (PLA plastic) (4C)
- D- Anterior capsule (Parafilm) (4D)
- E- Cornea (PVC Plastic) (4E)
- F- O-ring (Elastomer) (4F)



**Figure 4.** Photograph depicting the items used to create the eyeball model; (4A) - Lens (Beewax) (4B) - Sclera/Eyeball (PLA plastic) (4C) - Iris (PLA plastic) (4D) - Anterior capsule (Parafilm) (4E) - Cornea (PVC Plastic) (4F) - O-ring (Elastomer).

#### ASSEMBLY INSTRUCTIONS (Fig.5)

1. Recreate the lens on the eyeball (5A) by melting beewax in a metal spoon, directly into the fire, and placing it into the area intended for the model's lens.
2. Stretch the Parafilm<sup>®</sup> until it loses its elasticity and places it on top of the eyeball (5B)
3. Fit the iris over the lens and the Parafilm<sup>®</sup> (5C)
4. Fit the cornea over the eyeball and remove the unneeded Parafilm<sup>®</sup> (5D)
5. Fix the cornea in place, placing the o-ring around, in the idented region, marked on the eyeball (5E)





**Figure 5.** Photograph depicting steps of assembly of the eyeball model (5A) - Sclera/Eyeball enclosure with lens (5B) - Parafilm® stretched out and positioned, creating the anterior capsule (5C) - Iris positioned above the capsule (5D) - Cornea positioned above other structures (5E) - O'ring sealing the cornea into the eyeball (5F) Eyeball model completed.

### 3.3.2 Face and Content Model Validation

The second part of this study will be the model validation. Therefore, five veterinary ophthalmologists who have proficiency in performing the phacoemulsification technique will evaluate the canine eye model, and complete surveys to assess face and content validity with an open comments section. The participants will be asked to rank statements with one of the following options: strongly agree, agree, neutral, disagree, strongly disagree or not applicable/not answered (Table 1)

**Table 1:** Veterinary ophthalmologist face validation survey statements and responses (N=5)

Face validation statements	SA	A	N	D	SD	NA
The overall size of the model was appropriate for the skill						
All important structures were present						
The location of the structures was suitably realistic						
The texture of the materials felt appropriately realistic						
The model was easy to use						

The face validation statements and sum of the responses (N=5) in each category of agreement: SA= strongly agree; A=agree; N=neutral; D=disagree; SD=strongly disagree; NA=not applicable/not answered.

**Table 2:** Veterinary ophthalmologist content validation statements and responses (N=5)

Content validation statements	SA	A	N	D	SD	NA
The model was suitable to teach the preparation and steps required to perform the skill						
The model was suitable to give a general idea of the actual tactile experience when performing this skill						
I feel that this model would be helpful for students to practice the skill before performing it on a live animal						
I feel that this model is adequate to assess student performance of the skills stated						
I have no concern that this model could teach students poor technique						

The content validation statements and sum of the responses (N=5) in each category of agreement: SA= strongly agree; A=agree; N=neutral; D=disagree; SD=strongly disagree; NA=not applicable/not answered.

### 3.3.3 Statistical analyses

Likert-scored survey data will be evaluated with descriptive statistics and histograms.

### 3.4 DISCUSSION

The eyeball model size, of 20 mm of diameter, corresponds to an estimated value for canine species, as tabulated by Howland et al. (2004). The pupil diameter size of the model (9 mm) was slightly lower than the mean horizontal pupil diameter found in dogs ( $12.1 \pm 1.7$ mm), after 50 minutes of instillation of atropine sulphate (KOVALCUKA et al., 2017). Because if the pupil diameter were larger on the model, the iris would have to be even thinner, which would make 3D printing and assembling the model too difficult.

Some cataractous dog-owners choose to keep only medical management or to do no treatment at all, when presented with the potential complications of phacoemulsification (LIM et al., 2011). To prevent intraoperative complications, it is essential to improve technical capacity of the professionals. In medicine, step-by-step phacoemulsification training programs showed to be a satisfactory teaching system (DOOLEY & O'BRIEN, 2006; CARRICONDO et al., 2010; YULAN et al., 2013), decreasing major complications, as posterior capsule rupture and vitreous loss rates, with the progressing experience of the surgeon (COREY & OLSON, 1998; RANDLEMAN et al., 2007; CARRICONDO et al., 2010). Simulations offer ethical and safe alternatives for training and provide opportunities for the deliberate practice, what is important to achieving mastery in professional skills (SCALESE & ISSENBERG, 2005).

Phacoemulsification and capsulorhexis were subjectively the most difficult stages and had the lowest completion rates in the hands of trainee surgeons, in a prospective study that followed eight trainees during 100 consecutive cases of routine phacoemulsification cataract surgery (DOOLEY & O'BRIEN, 2006). Bringing it from medicine to veterinary, and also knowing that a successful continuous curvilinear capsulorhexis (CCC) during phacoemulsification reduces the rate of subsequent surgical complications, including posterior capsular tears and associated vitreous loss (MCCANNEL et al., 2013), it can be concluded that a good model should mainly allow the training of these two steps of phacoemulsification, which is our objective.

We choose the face and content validation, where experts provide feedback on the comprehensiveness and suitability of the model for teaching and assessment, because it allows assessing how the model performs as an educational intervention (NIBBLETT et al., 2015).

### 3.5 CONCLUSION

We are currently pursuing modifications of the model to achieve artificial structures closer to the real ones, focusing mainly on the steps of capsulorhexis and phacoemulsification, before submitting the model to face and content validation. After the statistical analyses, it will be possible to judge whether the model can be a substitute for pig eyes, since it has relatively low cost and easy access, reusable parts and allows more hours of training for professionals, before beginning to operate on real patients. However, it is important to note that in addition to model training, in-vivo training, accompanied by an experienced professional, is essential before operating alone.

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## 5 ANEXOS

### 5.1 APROVAÇÃO NO COMITÊ DE ÉTICA



UNIVERSIDADE FEDERAL DO PARANÁ  
SETOR DE CIÊNCIAS AGRÁRIAS  
COMISSÃO DE ÉTICA NO USO DE ANIMAIS

#### CERTIFICADO

Certificamos que o protocolo número 027/2019, referente ao projeto **“Influência da distância do tonometro na aferição da pressão intraocular de cães usando o tonometro de rebote Tonovet®”**, sob a responsabilidade **Fabiano Montiani Ferreira** – que envolve a produção, manutenção e/ou utilização de animais pertencentes ao filo Chordata, subfilo Vertebrata (exceto o homem), para fins de pesquisa científica ou ensino – encontra-se de acordo com os preceitos da Lei nº 11.794, de 8 de Outubro, de 2008, do Decreto nº 6.899, de 15 de julho de 2009, e com as normas editadas pelo Conselho Nacional de Controle da Experimentação Animal (CONCEA), e foi aprovado pela COMISSÃO DE ÉTICA NO USO DE ANIMAIS (CEUA) DO SETOR DE CIÊNCIAS AGRÁRIAS DA UNIVERSIDADE FEDERAL DO PARANÁ - BRASIL, com grau 2 de invasividade, em reunião de 08/05/2019.

Vigência do projeto	Julho/2019 até Dezembro/2019
Espécie/Linhagem	<i>Canis lupus familiaris</i> (cão)
Número de animais	30
Peso/Idade	12 kg/4 – 15 anos
Sexo	Macho e fêmea
Origem	Laboratório de Estudos em Nutrição Canina da Universidade Federal do Paraná, Curitiba, Brasil.

### CERTIFICATE

We certify that the protocol number 027/2019, regarding the project “**The influence of the tonometer distance on canine intraocular pressure measurements using the Tonovet® rebound tonometer**” under **Fabiano Montiani Ferreira** supervision – which includes the production, maintenance and/or utilization of animals from Chordata phylum, Vertebrata subphylum (except Humans), for scientific or teaching purposes – is in accordance with the precepts of Law nº 11.794, of 8 October, 2008, of Decree nº 6.899, of 15 July, 2009, and with the edited rules from Conselho Nacional de Controle da Experimentação Animal (CONCEA), and it was approved by the ANIMAL USE ETHICS COMMITTEE OF THE AGRICULTURAL SCIENCES CAMPUS OF THE UNIVERSIDADE FEDERAL DO PARANÁ (Federal University of the State of Paraná, Brazil), with degree 2 of invasiveness, in session of 08/05/2019.

Duration of the project	July/2019 until December/2019
Specie/Line	<i>Canis lupus familiaris</i> (canine)
Number of animals	30
Wheight/Age	12 kg/4 – 15 years
Sex	Male and female
Origin	Laboratório de Estudos em Nutrição Canina of the Federal University of Paraná, Curitiba, Brazil.

Curitiba, 08 de maio de 2019

*Chayane da Rocha*

Chayane da Rocha

**Coordenadora CEUA-SCA**

Comissão de Ética no Uso de Animais do Setor de Ciências Agrárias - UFPR





**COMISSÃO DE ÉTICA NO USO DE ANIMAIS – CEUA  
COMPLEXO PEQUENO PRÍNCIPE**


Curitiba, 12 de dezembro de 2018.

Prezada Sra. Claudia Sayuri Saçaki,

Comunicamos que o projeto intitulado “**Avaliação da terapia celular na retinopatia diabética**”, apresentado em reunião da Comissão de ética no uso de animais do Complexo Pequeno Príncipe, no dia 12 de dezembro de 2018, sob registro de número 041-2018, recebeu o parecer de “**Aprovado**”.

Obs: 55 ratos *Wistar* machos.

Atenciosamente,

  
 Prof. Dr. Sandro José Bonatto.  
 Vice-Coordenadora da CEUA – Complexo Hospitalar Pequeno Príncipe.

## 5.2 COMPROVANTE DE SUBMISSÃO DE ARTIGO CIENTÍFICO

### Veterinary Ophthalmology-submission confirmation

1 mensagem

David Wilkie <onbehalfof@manuscriptcentral.com>

Responder a: wilkie.1@osu.edu

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8 de abril de 2020 16:02

08-Apr-2020

Dear Professor Montiani-Ferreira:

Your manuscript entitled "INTRAOCULAR PRESSURE MEASUREMENTS USING THE TONOVET® REBOUND TONOMETER: REPEATABILITY AND INFLUENCE OF THE TONOMETER-CORNEA DISTANCE" by Rodrigues, Blanche, Bortolini, Mariza, Somma, André, Komaromy, Andras, Montiani-Ferreira, Fabiano, has been successfully submitted online and is presently being given full consideration for publication in Veterinary Ophthalmology.

Co-authors: Please contact the Editorial Office as soon as possible if you disagree with being listed as a co-author for this manuscript.

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Thank you for submitting your manuscript to the Veterinary Ophthalmology.

Sincerely,  
Veterinary Ophthalmology Editorial Office

### 5.3 MODELO DE TERMO DE CONSENTIMENTO

#### TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

**PROJETO:** INFLUÊNCIA DA DISTÂNCIA DO TONOMETRO NA AFERIÇÃO DA PRESSÃO INTRAOCULAR DE CÃES USANDO O TONOMÊTRO DE REBOTE TONOVET®

Orientador(a): Prof. Fabiano Montiani Ferreira

Pesquisador(a): Blanche Dreher Rodrigues, Mariza Bortolini.

Fone: ----

Endereço completo do local de estudo: R. dos Funcionários, 1540 - Cabral, Curitiba - PR, 80035-050

Pesquisas sobre diferentes métodos de aferição da pressão intraocular de cães têm sido realizadas, encontrando evidências de diferença significativa entre os valores obtidos com diferentes métodos.

No entanto, pouco foi investigado em relação à variação no posicionamento do equipamento em relação ao paciente. Este estudo tem como objetivos investigar a correlação entre os valores obtidos de pressão intraocular em cães da raça Beagle e diferentes distâncias entre o equipamento e o olho do paciente.

O estudo será realizado por meio da realização da tonometria de rebote, utilizando o aparelho TonoVet®, em quatro momentos para cada paciente. Uma aferição sem alteração no equipamento, e mais três aferições com três ponteiras afastadoras de tamanhos diferentes pré-estabelecidos, mas ainda dentro da variação estipulada pelo fabricante do equipamento.

Informamos que a presente pesquisa, além de não apresentar risco aos participantes, busca encontrar conhecimentos que poderão, futuramente, ajudar a definir se os resultados encontrados interferem na avaliação do médico veterinário oftalmologista, em busca de um diagnóstico mais preciso de doenças importantes como o glaucoma e a uveíte.

Esclarecemos, ainda, que os dados resultados de cada participante são confidenciais e sua identidade será mantida em sigilo nas divulgações posteriores. Tais informações serão utilizadas para fins acadêmicos, podendo ser apresentadas em congressos, publicações ou outra forma de divulgação nacional ou internacional.

Sendo assim, convido o Sr./Sra. \_\_\_\_\_

CPF \_\_\_\_\_ a autorizar o seu cão \_\_\_\_\_ da raça Beagle, a participar da presente pesquisa.

Ressalta-se que você tem todo o direito de não autorizar e em qualquer momento da pesquisa interromper sua participação, devendo somente avisar o pesquisador de sua desistência.

Caso concorde, solicitamos a gentileza de concretizar sua concordância, assinando esse termo de consentimento livre e esclarecido.

#### CONSENTIMENTO LIVRE E ESCLARECIDO

**Declaro** que li as informações acima sobre a pesquisa, que me sinto perfeitamente esclarecido(a) sobre o conteúdo da mesma. Declaro ainda que, por minha vontade, autorizo meu cão a participar da pesquisa cooperando com a realização de exames necessários.

Curitiba, \_\_\_\_/\_\_\_\_/\_\_\_\_.

\_\_\_\_\_  
Assinatura do tutor/responsável

Testemunha # 1: \_\_\_\_\_

Testemunha # 2: \_\_\_\_\_



## 5.4 VITA

### **Blanche Dreher Rodrigues**

#### **Dados pessoais**

**Nome** Blanche Dreher Rodrigues

**Nascimento** 16/12/1984 - Rio de Janeiro/RJ - Brasil

#### **Formação acadêmica/titulação**

**2008-2010** ESPECIALIZAÇÃO EM OFTALMOLOGIA VETERINÁRIA. Universidade Anhembí Morumbi, UAM, São Paulo, Brasil (ANCLIVEPA-SP)

Título: IMPLANTE DE LENTES INTRA-OCULARES EM CÃES - REVISÃO DE LITERATURA E RELATO DE CASO

Orientador: Professor Doutor Paulo Cesar Silva

**2003-2007** Graduação em Medicina Veterinária. Universidade Estadual Paulista Júlio de Mesquita Filho, UNESP, São Paulo, Brasil.

Título: Toxoplasmose Ovina: Aspectos Gerais E De Saúde Pública

Orientador: Helio Langoni

#### **Formação complementar**

**2015-2015** Curso de curta duração em ATUALIZAÇÃO EM MEDICINA DE URGÊNCIA E INTENSIVA DE PEQUENOS ANIMAIS. (Carga horária: 66h). EQUALIS, EQUALIS, Brasil

**2014-2014** Curso de curta duração em FOTOGRAFIA - ARTE E TÉCNICA. (Carga horária: 30h). Serviço Nacional de Aprendizagem Comercial - PR, SENAC/PR, Irati, Brasil

**2011-2011** Curso de curta duração em Transferência de Habilidade Em Facoemulsificação. (Carga horária: 40h). Dr. Newton Kara José Júnior, NKJJ, Brasil

#### **Atuação profissional**

1. Centro Integrado de Especialidades Veterinárias - CIEV

##### **Vínculo institucional**

**2015 - Atual**

Vínculo: Médica Veterinária, Enquadramento funcional: Oftalmologia Veterinária (ProOftalmoVet).

2. Hospital Veterinário Santa Mônica - HVSM

##### **Vínculo institucional**

**2015 - Atual**

Vínculo: Médica Veterinária, Enquadramento funcional: Clínica geral, Cirurgia e Oftalmologia Veterinária.

3. Policlínica veterinária Botafogo - PCVB

**Vínculo institucional**

**2008 - 2014** Vínculo: Médica Veterinária , Enquadramento funcional: Clínica geral, Cirurgia e Oftalmologia Veterinária.

**Produção**

**Artigos completos publicados em periódicos**

1. SOMMA, ANDRÉ TAVARES; MORENO, JUAN CARLOS DUQUE; SATO, MARIO TERUO; **RODRIGUES, BLANCHE DREHER**; BACELLAR-GALDINO, MARIANNA; OCCELLI, LAURENCE MIREILLE; PETERSEN-JONES, SIMON MICHAEL; MONTIANI-FERREIRA, FABIANO. Characterization of a novel form of progressive retinal atrophy in Whippet dogs: a clinical, electroretinographic, and breeding study. VETERINARY OPHTHALMOLOGY. , v.20, p.450 - 459, 2016.

1. DA VEIGA, C. C. P.; BOMFIM, P. C.; OLIVEIRA, P. C.; SOUZA, B. G.; LASMAR, P.; OLIVEIRA, G. F.; PERLMANN, E.; **RODRIGUES, BLANCHE DREHER** ASPECTO ULTRASSONOGRÁFICO DA UVEÍTE UNILATERAL CANINA - RELATO DE CASO. REVISTA BRASILEIRA DE MEDICINA VETERINÁRIA, v.35(1), p.11 - 14, 2013.

**Trabalho apresentado de forma oral em evento**

1. **RODRIGUES BD**, PERLMANN E, REI PRL, SOMMA AT. SARCOMA HISTIOCÍTICO INTRA-OCULAR EM UM CÃO:ACHADOS CLÍNICOS, HISTOPATOLÓGICOS E IMUNOHISTOQUÍMICOS. 6º Congresso Latinoamericano de Oftalmologia Veterinaria (CLOVE). 6-7 de junho de 2011.

**Trabalhos publicados em anais de eventos (completo)**

1. ESTANISLAU, Caroline de Abreu; BRANDÃO, Cláudia Valéria Seullner; MINTO, Bruno Watanabe; RANZANI, J. J. T.; SHIMIZU, Ricardo Kendy; **RODRIGUES, Blanche Dreher**. Estudo experimental da utilização da abraçadeira de nylon comparada ao fio de aço na cerclagem óssea em ratos In: XIII Encontro Nacional da Associação Brasil-Japão de Pesquisadores, 2005, Botucatu. **SBPN - Scientific Journal**. , 2005. v.9. p.38 - 38

**Trabalhos publicados em anais de eventos (resumo)**

1. Leiva, M; Sakiyama, D.T.P; Catenacci, L.S; Fornazari, F; Pinheiro, R.T; Gonçalves, V.T; Belo, C.P.; Thomazini, C.M; **RODRIGUES, Blanche Dreher**; Fonseca, R.C,B. Mapeamento de fauna do Jardim Botânico do Instituto de Biociência da Unesp de Botucatu In: IV ESAS, 2005, Poços de Caldas. IV ESAS, 2005.

2. Leiva, M; Sakiyama, D.T.P; Catenacci, L.S; Fornazari, F; Pinheiro, R.T; Gonçalves, V.T; Belo, C.P.; Thomazini, C.M; **RODRIGUES, Blanche Dreher**; Fonseca, R.C,B. Mapeamento de fauna do Jardim Botânico do Instituto de Biociência da Unesp de Botucatu In:

Encontro de Iniciação Científica de 2004, 2004, Botucatu. Encontro de Iniciação Científica de 2004, 2004.

3. Leiva, M; Sakiyama, D.T.P; Catenacci, L.S; Fornazari, F; Pinheiro, R.T; Gonçalves, V.T; Belo, C.P.; Thomazini, C.M; **RODRIGUES, Blanche Dreher**; Fonseca, R.C,B. Mapeamento de fauna do Jardim Botânico do Instituto de Biociência da Unesp de Botucatu In: VIII Semana da Bio, 2004, Botucatu. VIII Semana da Bio, 2004.